

Natural Gas Vehicles in California



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CLEAN TRANSPORTATION & ENERGY CONSULTANTS

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GNA Overview

- North America's Leading Full Service NGV Project Consulting Firm
- Santa Monica & New York City
- 20+ Years of NGV Industry Experience and Expertise
- Diverse Staff of 40+ Engineers, Market Development, and Policy & Public Affairs Experts



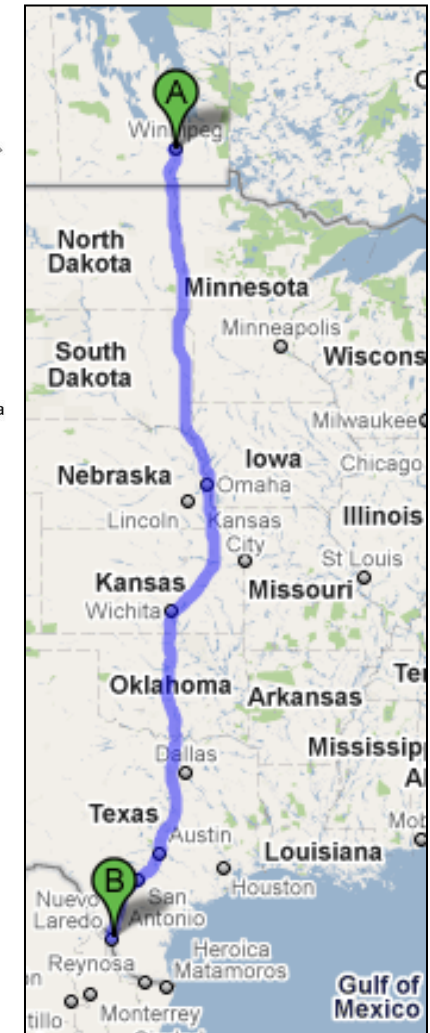
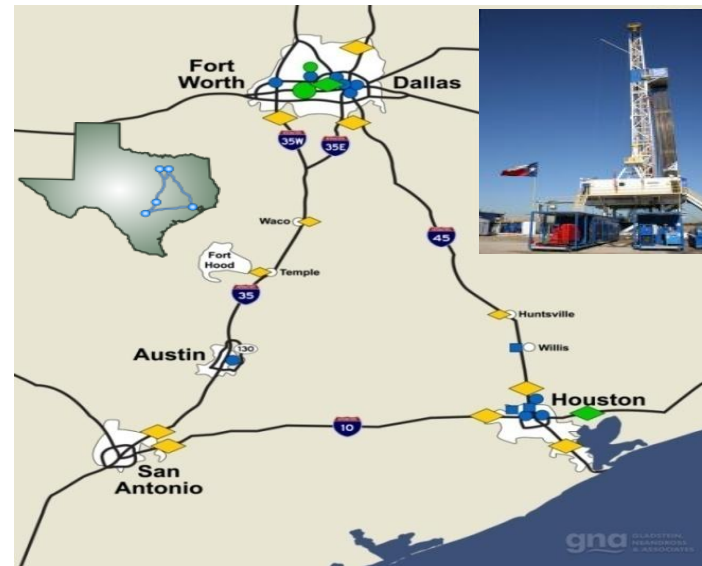
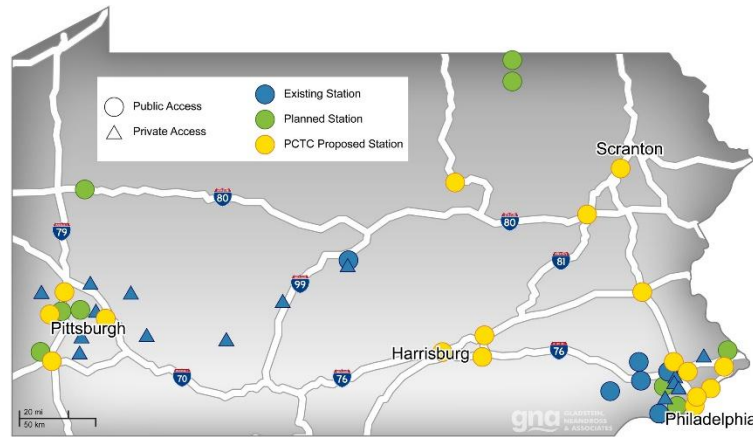
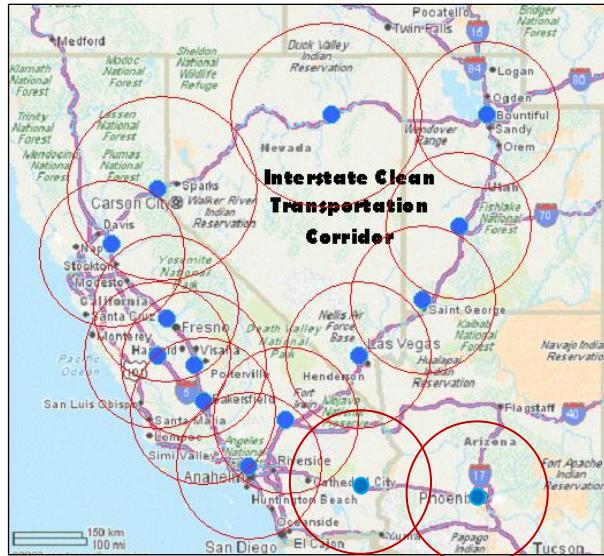
Heavy-Duty NGV Deployment



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GNA NG Corridor Projects



GNA HHP NG Projects



Opportunities for NGVs

What are the market opportunities for Natural Gas as a transportation fuel?

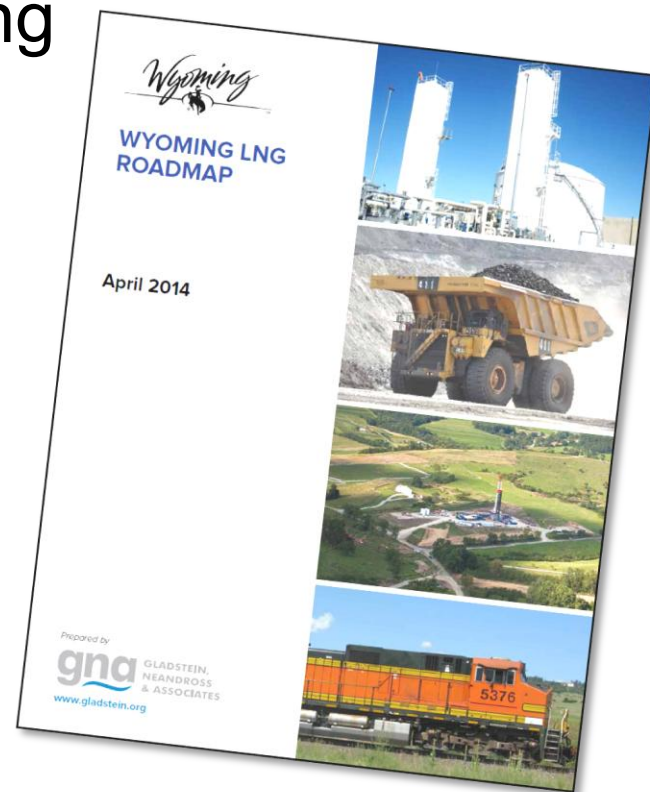
- On-road heavy-duty – it's working
- “Fuel hungry” off-road
 - Marine
 - Locomotive
 - Mine Haul Trucks
 - Drill Rigs (Oil & Gas)
 - Frac Rigs
 - Power



Opportunities for NGVs

1. What are the market opportunities for Natural Gas as a transportation fuel?

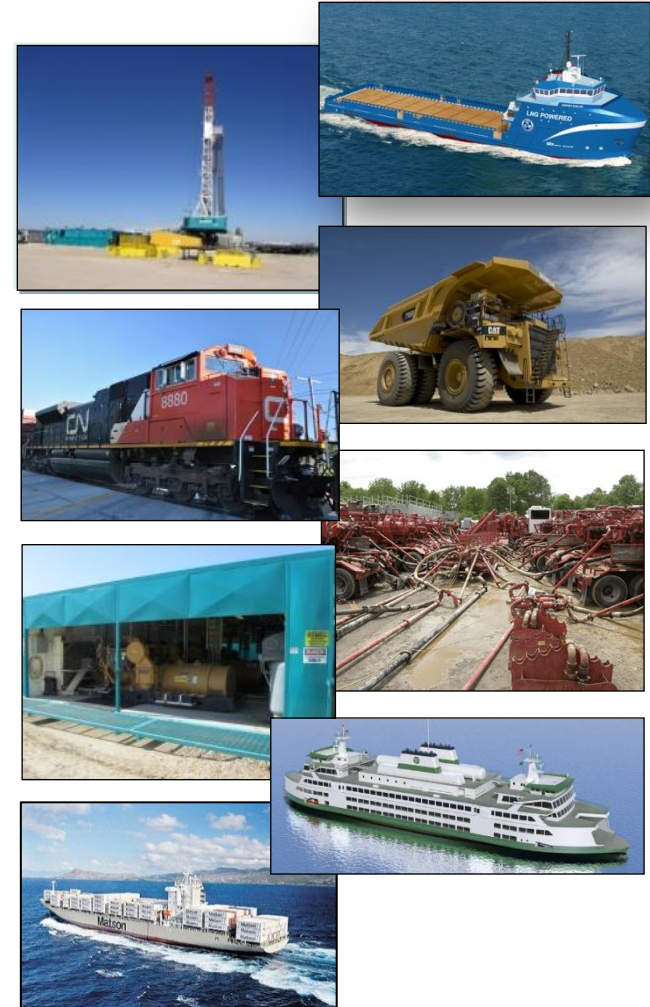
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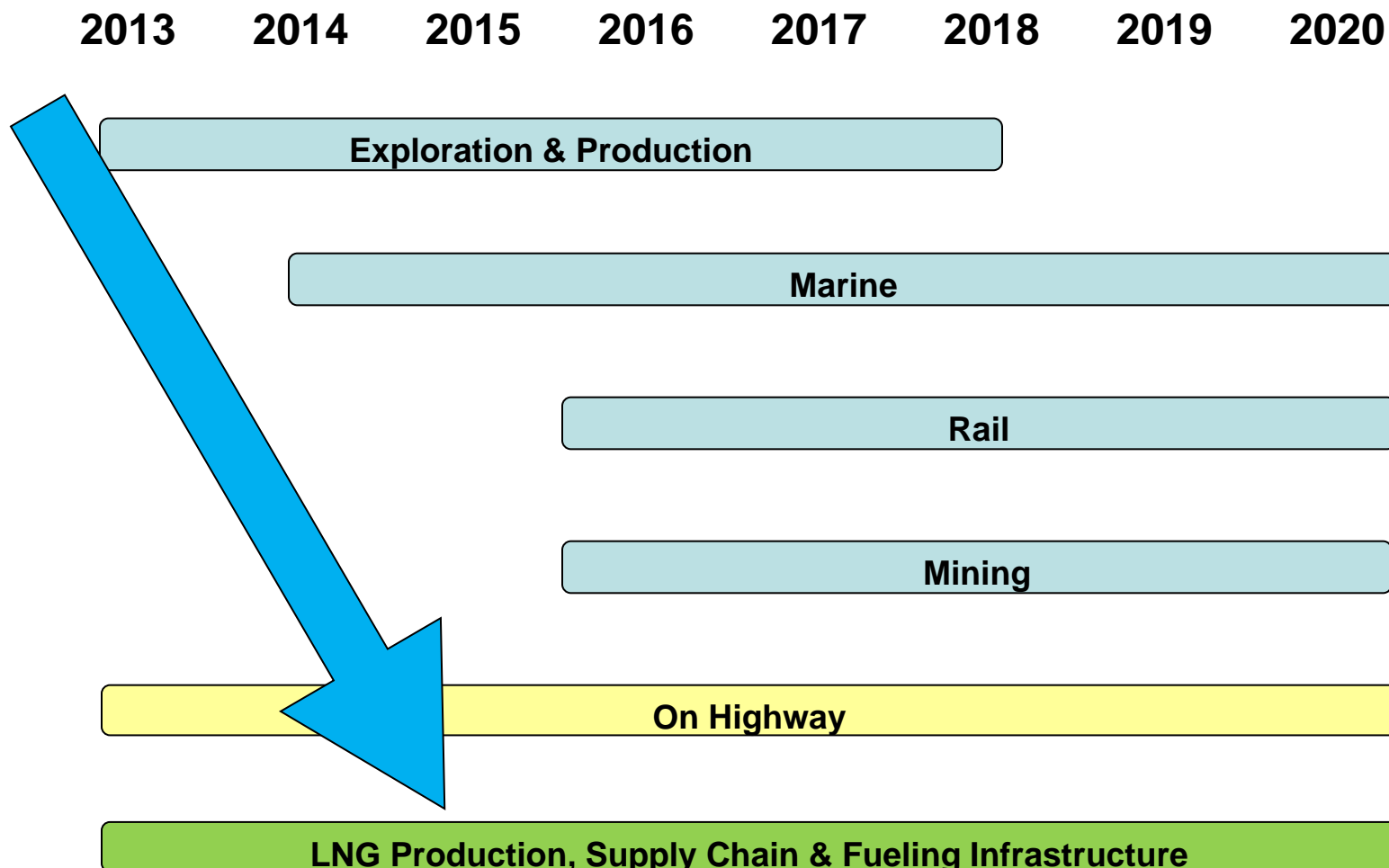
Opportunities for NGVs

Typical *per unit* fuel use in the off-road HHP sector

	Fuel Use (DGE/year)
Small Container Ship	35,000,000
Frac Crew	2,000,000
Ferry vessel	800,000
Drill Rig	800,000
Mine haul truck	500,000
Line haul locomotive	250,000



Commercial LNG Fuel Market Development Timelines



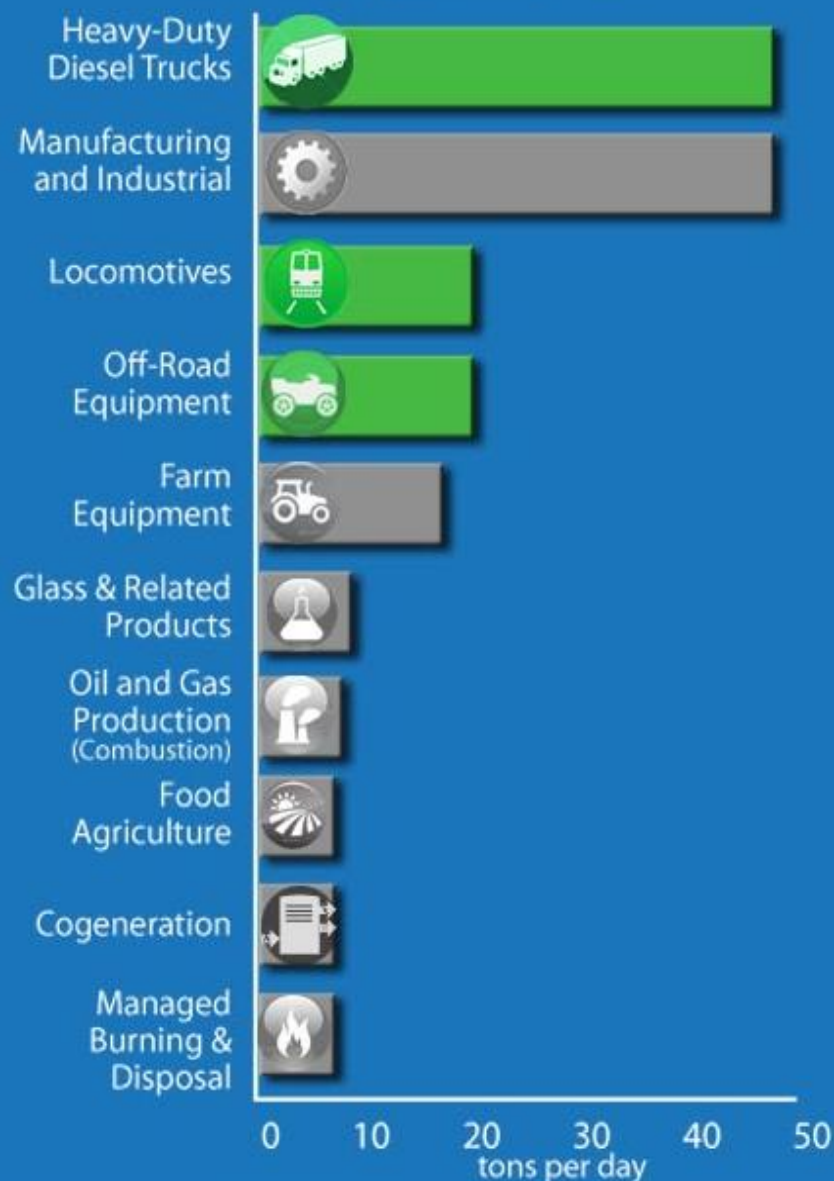
Top 10 NOx Source Categories (2023 Projections)

Mobile Sources with Good Potential for Natural Gas Conversion

SCAQMD Summer NOx



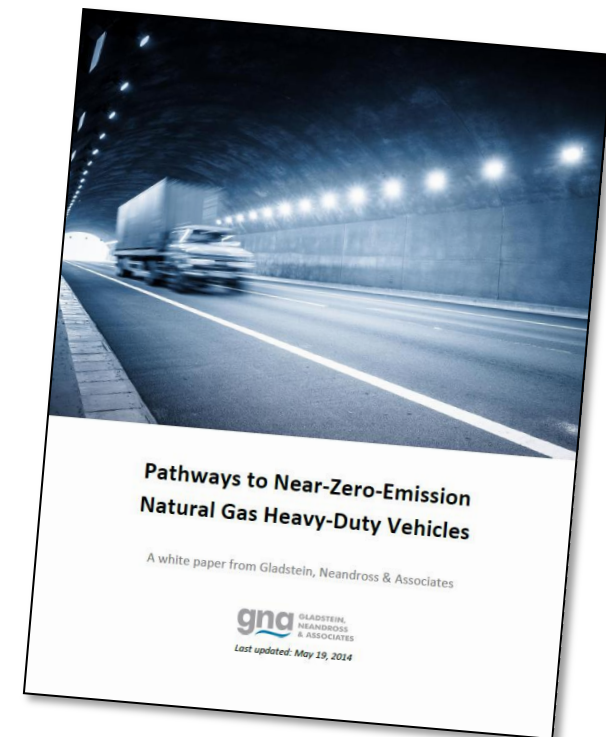
SJVAPCD Summer NOx



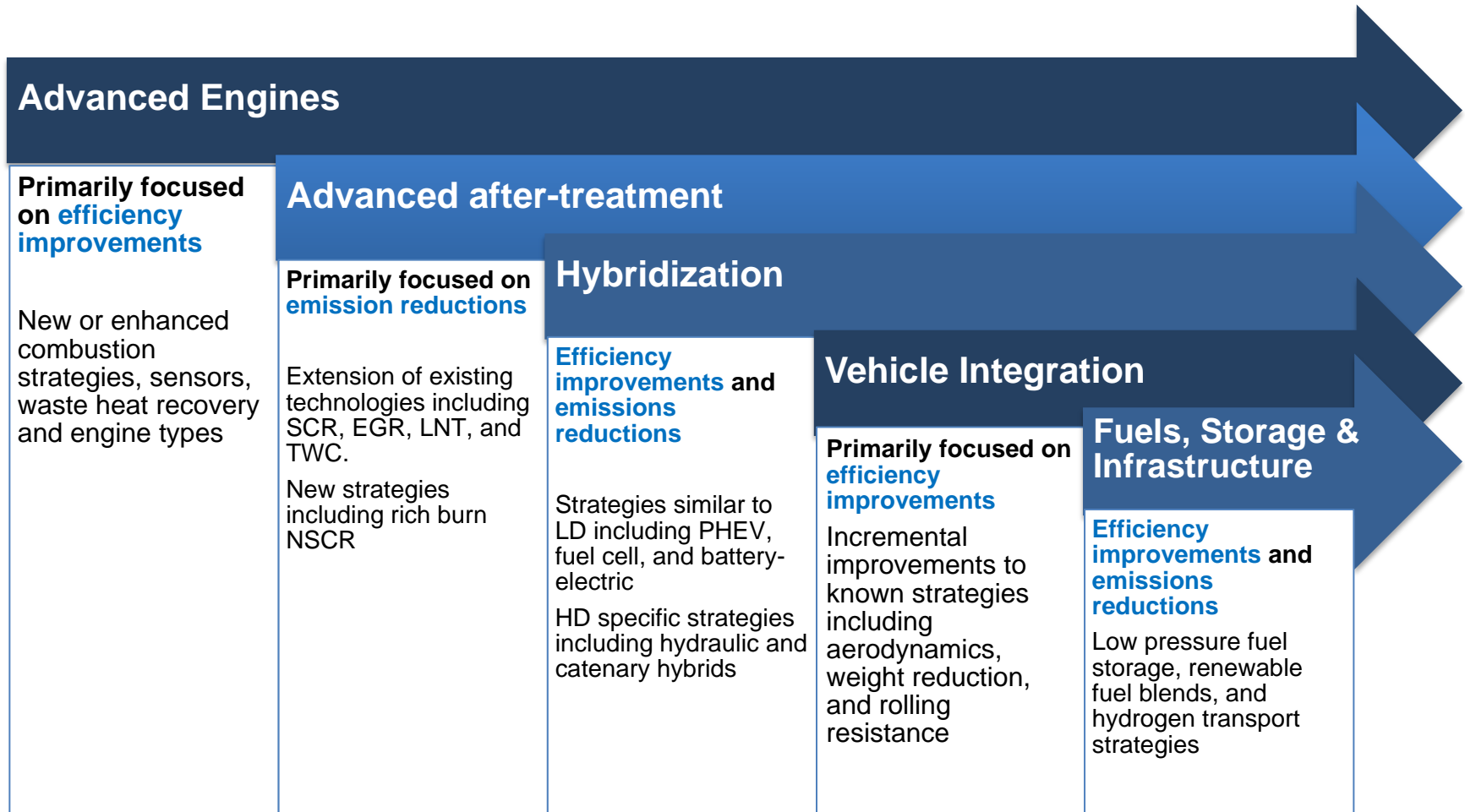
Long Term Benefits from NGVs

2. Should natural gas be considered as:

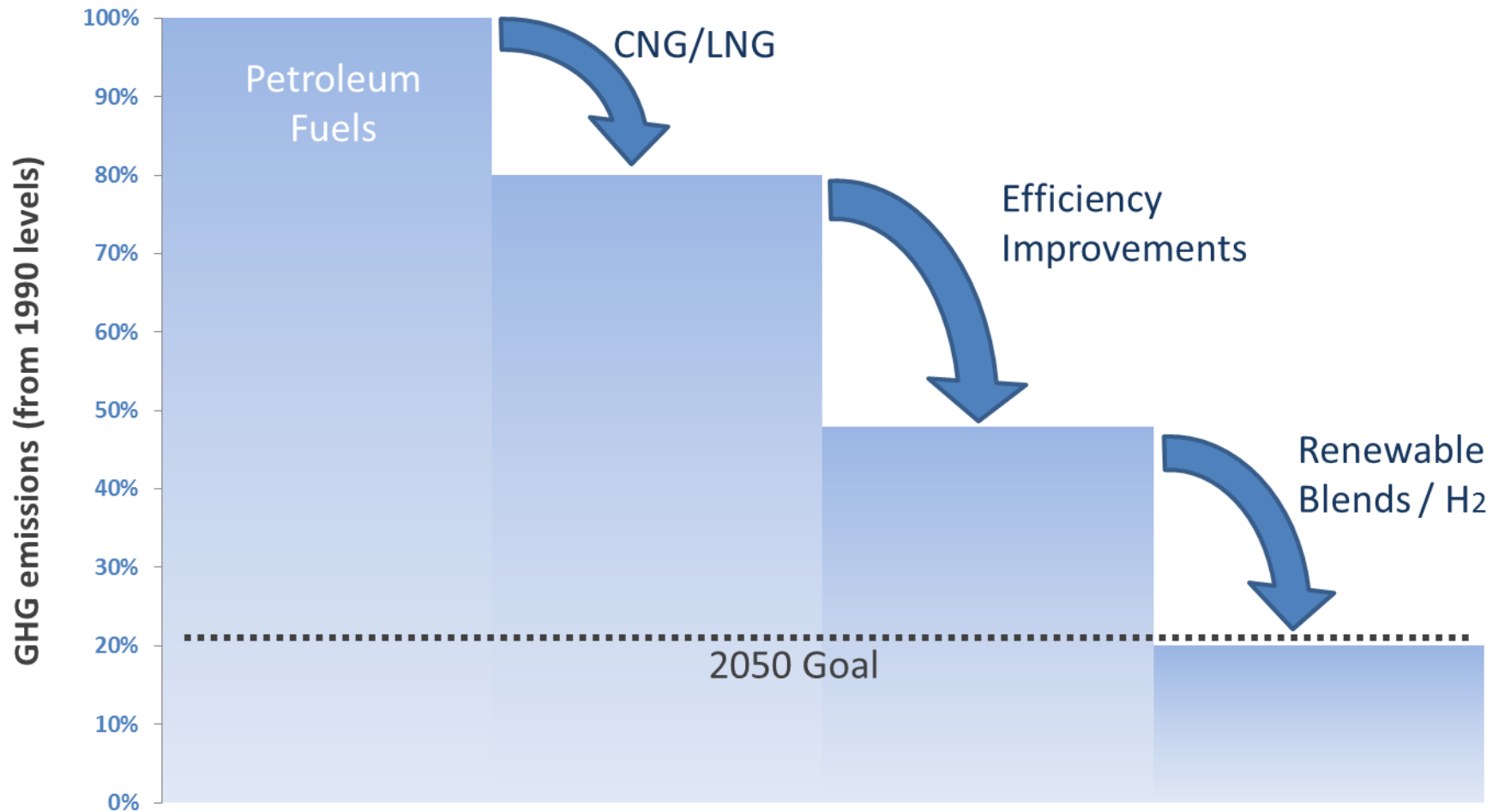
- A near-term, low cost bridging fuel with moderate environmental benefits? Or,
- As a potential ZEV-caliber truck fueling option with the potential to meet the environmental performance standards associated with electricity and hydrogen?
- Yes to both.
 - Assumes “near term” = next 5 years and “long term” is everything beyond 5 years
- Not a bridge fuel. Part of a long term diverse portfolio.
- Infrastructure is the bridge; need to keep building.
- Near-zero emission natural engines (0.02 g/bhp-hr NOx) available ~ 2017 – 2018.
 - Reduce NOx by 90% from today’s standards – not a “moderate” environmental benefit
 - “Power plant equivalent” emissions - competitive with fuel cell and EV technologies for NOx
 - Important under lower NAAQS for O3
 - Renewable natural gas one of the lowest carbon intensities of all LCFS fuels, even when accounting for efficiency of EVs and FCVs
 - No diesel PM / black carbon



Five Natural Gas Technology Pathways



Advanced Heavy-Duty NGVs Can Achieve GHG Goals through a Combination of Strategies



Long Term Benefits from NGVs

3. How should policy makers and regulators consider the long-term potential for natural gas as a transportation fuel given the risk and uncertainties associated with methane leakage and potentially higher carbon intensity values?

- California needs all low- and zero-carbon fuel options. We cannot sit on the sidelines and wait to see how the methane leakage issue plays out.
- California's NG transportation & distribution system has very low methane leakage
 - Be careful in applying data from other states to California; not the same as the East Coast
 - Solutions to reduce methane leakage are available and the issue is being worked on
 - Diesel carbon intensity is trending upward due to unconventional oil sources
- Renewable natural gas – part of long term solution
 - Don't have the same leakage concerns here, especially when produced & used in state.
- Leverage current momentum and ramping of growth to continue to build infrastructure, fuel supply & supply chain



Renewable Natural Gas

4. What are the opportunities and constraints for using biogas at a commercial fueling scale in California?

- Huge number of resources and thus opportunities.
- California should be a global leader and work to maximize development and utilization of bio-methane.
- Policy & regulation to incentivize, encourage and allow bio-methane in California's pipeline network – the State can help overcome constraints



Future NGV Products

5. What changes in natural gas engine design and sizing options are needed to make natural gas trucks **more** competitive in California and the West? When can we expect sizeable numbers of vehicle products?

- Today's product (CWI ISX 11.9) can meet a huge portion of the market's needs
- Potential 20% market penetration by HD NGVs by 2020
- Near-zero emission CWI engine available in 2017-2018 timeframe.
- NGVs can / will continue to evolve alongside diesel and other alternative fuel options.
 - improved aerodynamics
 - increased engine efficiency
 - weight reduction
 - driveline electrification
- California needs to send clear signals to OEMs that we want and need all sizes of near zero natural gas engines, and that the State will incentivize and promote their purchase and use.

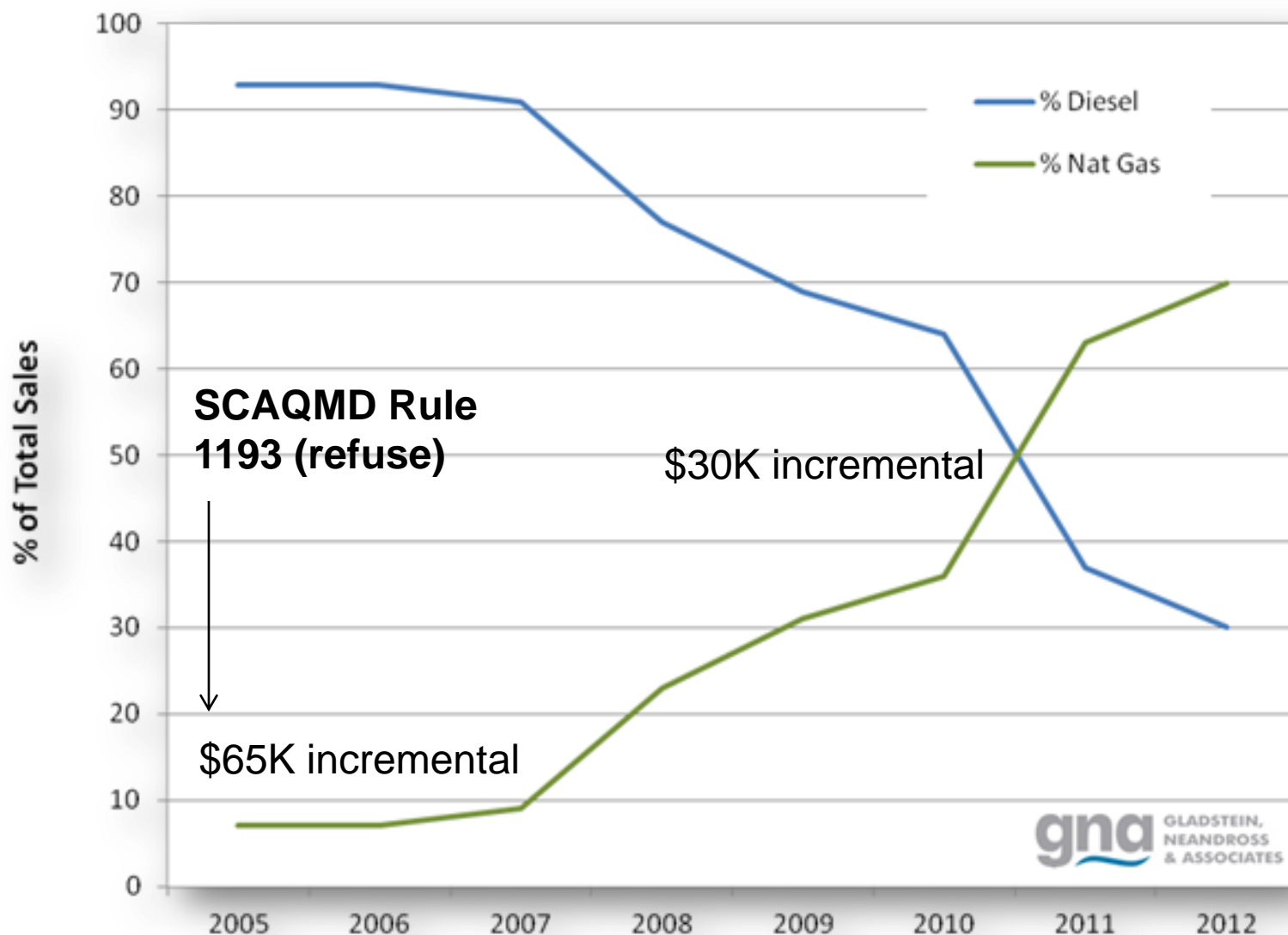


Fleet Needs

6. What do fleet operators need from OEMs and government policy makers and regulators to make natural gas trucks a **more competitive alternative to diesel-fueled trucks?**

- More fueling infrastructure
- More buyers – i.e. other fleets
 - The State of California and public agencies within the state have huge purchasing power → more product and lower incremental costs
- Clear and consistent policies and laws that offer a level playing field.
 - Fair taxation, accounting for market externalities, etc.
- Innovative new incentive programs
 - Continue to stimulate and drive technology innovation, infrastructure development and renewable methane supplies
 - Monetize multi-media environmental benefits, not just criteria pollutants (lower GHGs; increased petroleum displacement / energy security; reduced air, water and soil toxins; etc.)

OEM X: N.A. Diesel & NG Refuse Truck Sales



Shippers Driving NGV Investment

P&G



COLGATE-PALMOLIVE



PEPSICO



GENERAL MILLS



Tropicana
PURE PREMIUM

HERSHEY'S

The Hershey Company

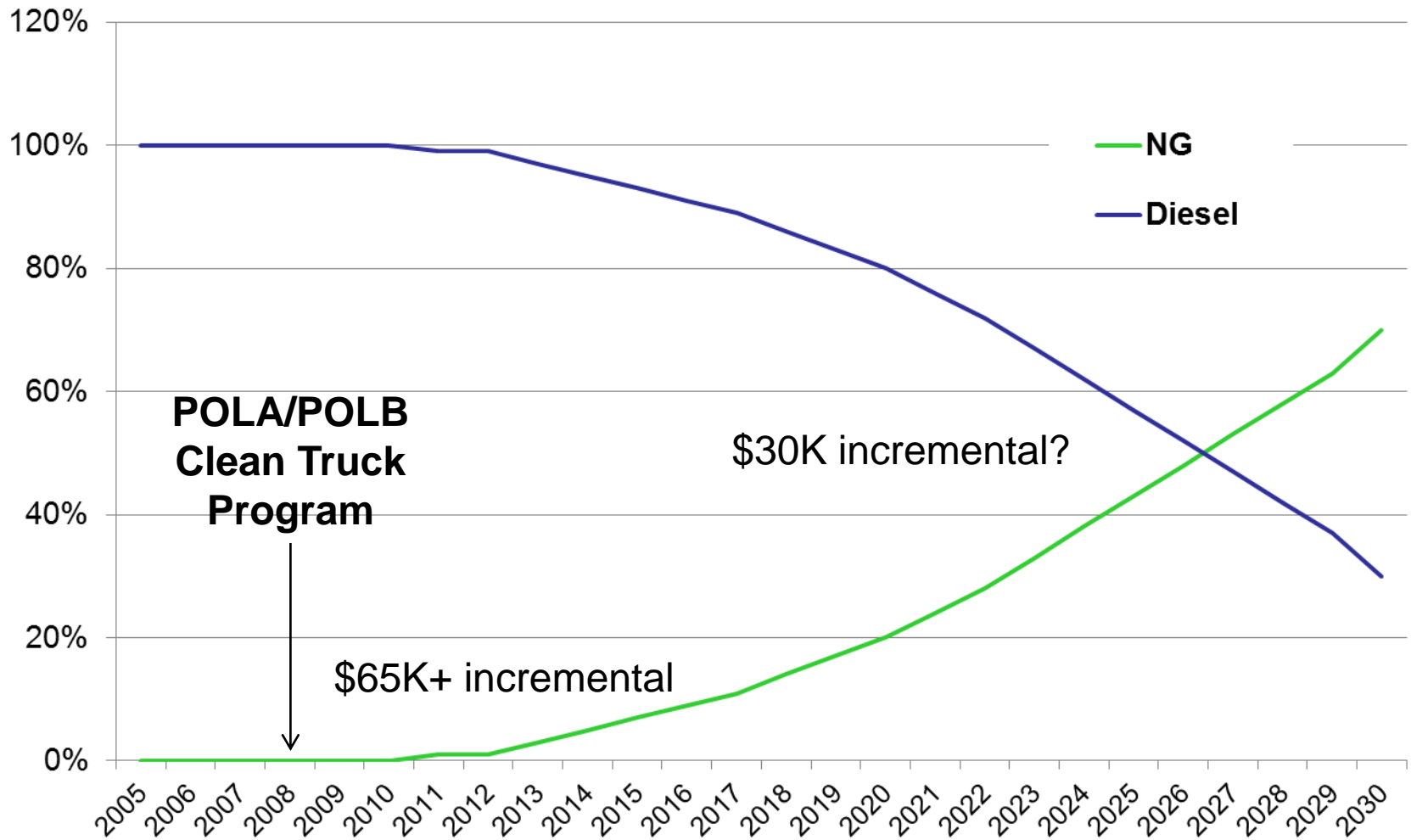


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Future Market Growth?



Summary

**FASTER EMISSIONS
REDUCTIONS AHEAD**



Thank You!



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